

*The
Biologist*



Vol. XXII, No. 1

October, 1940

Phi Sigma

BIOLOGICAL HONOR SOCIETY

"The object of Phi Sigma is to promote interest in biological research. Although originally designated as an honorary biological research society, it should now be considered as a working guild of biologists interested in research. In effect, election to Phi Sigma should be an opportunity for better work, rather than merely election to an honorary society."

Mile Posts:

- 1915 March 17, Alpha Chapter organized, Ohio State University, Columbus.
- 1916 May, Central Governing Body organized, BIOLOGIST first issued.
- 1917 June, last War-time BIOLOGIST issued.
- 1921 February, BIOLOGIST revived.
- 1924 December, First National Meeting, Constitution revised, Washington, D. C.
- 1925 December, Second National Meeting, First Scientific Program, Kansas City.
- 1926 December, Third National Meeting, Second Science Program, Philadelphia.
- 1927 December, Third Science Program, Nashville.
- 1928 December, Fourth National Meeting, Coat-of-Arms adopted, Fourth Science Program, New York.
- 1930 January, Council Meeting, Ritual Revised, Norman, Okla.
December, Fifth National Meeting, Fifth Science Program, Cleveland.
- 1931 Phi Sigma Letters Registered, U. S. Patent Office.
- 1932 December, Sixth Science Program, Atlantic City.
- 1933 June, Sixth National Meeting, Seventh Science Program, Chicago.
- 1935 December, Seventh National Meeting, Eighth Science Program, St. Louis.
- 1937 December, Eighth National Meeting, Ninth Science Program, Indianapolis.
- 1939 December, Ninth National Meeting, Tenth Science Program, Silver Anniversary, Ohio State University, Columbus.

Expansion:

The Constitution provides that: "An active chapter may be established in any institution of learning which requires for graduation the equivalent of four years of collegiate work, and which is equipped with facilities for research work. - - - Any petitioning group must be active for at least one year before it may be granted a charter."

THE BIOLOGIST

Vol. XXII

Denver, Colo., October, 1940

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Published by the Phi Sigma Society, an organization devoted to the promotion of interest in biological research, founded at Ohio State University, March 17, 1915. The *Biologist* is the official quarterly publication of the society, issued ordinarily in October, December, February and April, as a medium of exchange between chapters, as an interpreter of Council policies, and as a stimulus to the fellowship in science for which Phi Sigma stands.

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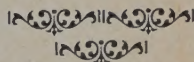
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OF ALL ACTIVE AND INACTIVE CHAPTERS

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ALPHA

Ohio State University, Columbus, Ohio, founded March 17, 1915, (Inactive).

BETA

University of Michigan, Ann Arbor, Michigan, founded June 3, 1916.

DELTA

University of Maine, Orono, Maine, founded January 27, 1917, (Inactive).

EPSILON

University of Denver, Denver, Colorado, founded March 5, 1917.

ZETA

University of Wisconsin, Madison, Wisconsin, founded May 30, 1917

ETA

University of Akron, Akron, Ohio, founded April 20, 1921.

THETA

Michigan State College, East Lansing, Michigan, founded April 9, 1921, (Inactive).

IOTA

Washington University, St. Louis, Missouri, founded May 28, 1921.

KAPPA

University of Kansas, Lawrence, Kansas, founded May 31, 1921.

LAMBDA

Montana State University, Missoula, Montana, founded May 4, 1921.

MU

University of California, Berkeley, California, founded April 27, 1922.

NU

Washington and Jefferson College, Washington, Pennsylvania, founded May 11, 1922

XI

University of Nebraska, Lincoln, Nebraska, founded May 3, 1924, (Inactive).

OMICRON

University of North Dakota, Grand Forks, North Dakota,
founded May 26, 1924, (Inactive).

PI

Emory University, Georgia, founded January 3, 1925.

RHO

University of Illinois, Urbana, Illinois, founded March 28, 1925.

SIGMA

University of Florida, Gainesville, Florida, founded December 4, 1925.

TAU

Duke University, Durham, North Carolina, founded March 4, 1926.

UPSILON

Miami University, Oxford, Ohio, founded May 7, 1926.

PHI

University of New Hampshire, Durham, New Hampshire, founded May 21, 1926.

CHI

Montana State College, Bozeman, Montana, founded February 11, 1927.

PSI

University of Washington, Seattle, Washington, founded April 7, 1928.

OMEGA

University of Oklahoma, Norman, Oklahoma, founded March 24, 1928.

ALPHA ALPHA

University of Southern California, Los Angeles, California, founded May 17, 1930.

ALPHA BETA

Mount Union College, Alliance, Ohio, founded May 17, 1928.

ALPHA GAMMA

University of South Dakota, Vermillion, South Dakota, founded May 15, 1928, (Inactive).

ALPHA DELTA

Lawrence College, Appleton, Wisconsin, founded March 7, 1929, (Inactive).

ALPHA EPSILON

University of Pittsburgh, Pittsburgh, Pennsylvania, founded March 23, 1929.

ALPHA ZETA

College of William and Mary, Williamsburg, Virginia, founded April 19, 1930, (Inactive).

ALPHA ETA

Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma, founded March 13, 1930.

ALPHA THETA

State College of Washington, Pullman, Washington, founded May, 1930.

ALPHA IOTA

Bucknell University, Lewisburg, Pennsylvania, founded January 9, 1932.

ALPHA KAPPA

Hunter College, New York City, founded January 8, 1932.

ALPHA LAMBDA

University of Utah, Salt Lake City, Utah, founded February 13, 1932.

ALPHA MU

University and State College of Oregon, Eugene-Portland-Corvallis, Oregon, founded November 18, 1933.

ALPHA NU

University of New Mexico, Albuquerque, New Mexico, founded April 21, 1935.

ALPHA XI

Rhode Island State College, Kingston, Rhode Island, founded May 17, 1935.

ALPHA OMICRON

Marquette University, Milwaukee, Wisconsin, founded June 18, 1938.

*The Causal Embryology of the Vertebrates**

By LEIGH HOADLEY

Biological Laboratories, Harvard University

For more than half a century students of experimental embryology have held as their objective the identification of causal relationships which are responsible for specific developmental events. The challenge to the epigenetists and the preformationists found in His's monograph on "Our body form and the physiological method of its origin" and contained in the theory of germinal localization, was accepted first by Wilhelm Roux and later by others. As the result of his experiments, Roux formulated the classical postulates of dependent development, independent development, and post-generation. Most of the earlier experiments were carried out on the egg of anurans but similar studies were soon initiated on the eggs of a great variety of animals.

Examination of the postulates of Roux shows that the conception of independent development implies a self sufficiency or autonomy of the processes of development and that post-generation implies self-regulatory capacities. In cases of dependent development there is the possibility of causal analysis. Independent self-differentiation has been described in the past in terms of preformation, of mosaic development, and of determinate development. Dependent development, on the other

hand, involves cooperation between parts of the organism and hence, processes which are more obviously epigenetic. The fact has long been appreciated that the degree of restriction varies greatly in eggs of different groups and that the initial epigenetic development of all eggs results in the formation of a germ composed of parts of greatly restricted potency and hence of a mosaic type. The subsequent development of the parts of such germs is by independent self-differentiation.

The eggs of most of the invertebrates may be classified according to the degree of restriction at the time of fertilization and at the time of the first cleavage. The causal analysis of their development has been difficult for obvious reasons, though Seidel, working with insects, Hörstadius and Runnström with the echinoderms, and others with the eggs of many other animals by means of defect experiments, isolated blastomeres, and fused ova have made important contributions to the subject. We should remember that the first postulation of induction as a process of development is to be found in a study of echinoderm development by Driesch.

By far the most important contributions to the study of causal relations in development are to be found in reports of experiments on the developing eggs of the vertebrates, more especially those of the amphibia and the birds.

*The following paper is the English version of the eleventh of a series of lectures given at the Sorbonne during the winter and spring of 1939.

These experiments fall naturally into four general categories, those dealing with the topography of the embryo at all stages in its development, those which are concerned with the discovery of the capacity for independent self-differentiation vested in parts of the embryo, those which are designed to test and define the causal relations responsible for divergence, and those in which efforts have been made to determine the chemical nature of inducing substances and their action. We shall consider each of these in some detail.

The topography of the germ, which is readily appreciated by a study of the cell lineage in many forms, cannot readily be studied by this method in the vertebrates because of the absence of identifying marks and of differential cell divisions. Descriptive embryology has done much to outline the fates of parts of the embryo. Defect experiments, especially those of Brachet on the frog and of Assheton, Peebles, Kopsch, and Patterson on the chick have made our knowledge of the presumptive fates of the parts of the embryo more exact. More recently, the use of marks made by staining with vital dyes such as neutral red or Nile blue sulphate (first used by Goodale in 1911) has enabled investigators to study the fate of many parts of the eggs of the amphibia and the chick as well as those of other forms. This method is particularly important in that it permits the determination of the course of cell migrations the extent of which had not previously been comprehended. Such studies have been made on the blastoderm of the chick by Wetzel, Pasteels, and Kopsch, and on the eggs of a number of amphibian species by Vogt, Goettler, Pasteels, Wintrebert and others. While some most interesting observations have been made on the development of the

fish blastoderm especially by Luther, Pasteels, Oppenheimer, Vanderbrock, Kopsch and Wintrebert, we shall confine our attention here to the results obtained from the study of the chick and the amphibia.

In order to apply the stain to a localized area of the egg or the blastoderm, pieces of agar are deeply stained in a dilute solution of the dye to be used. These are then dried and, just prior to use, are placed in Ringer solution where they give off the excess of the dye. They are then cut into small pieces and placed on the embryo in any desired position. By alternating the dyes employed, usually neutral red and Nile blue sulphate, an easily recognized pattern may be transferred to the egg. This may then be followed through subsequent developmental stages. By means of a systematic and very complete series of such marks together with constant examination of their locations, investigators have been able to map the areas of the egg and their activities very completely. It should be borne in mind that the areas which are located are described in terms of their fates and not in terms of their potencies. Especial attention has been drawn to the position of the future dorsal lip of the blastopore and the relation between that point and the mesodermal, chordal, and endodermal regions of the germ.

Vital stain experiments upon the blastoderm of the bird's egg are more difficult to execute than upon the embryos of amphibia, because of the presence of the enveloping albuminous coats. Wetzel and Pasteels have been successful in making localized marks. Our present knowledge of the topography of the chick blastoderm has been derived from the results of their experiments supplemented by cinematographic studies by Graeper. In con-

trast to the rather detailed localization of primordia possible in the amphibia, the examination of the bird blastoderm has permitted only the detection of the grosser relationships within the germ.

Most of the information based on the use of vital stains has been obtained relatively recently. Previously the topography of the developing embryo was built up from the interpreted results of defect experiments and of experiments depending on the positive differentiation of structures in portions of the embryo which were caused to develop in foreign locations. This can be accomplished by means of tissue cultures and by means of embryonic transplantations. Both the latter methods were developed by Harrison and have yielded considerable information at his hands. Embryonic transplantations have been carried out on parts of the embryo in both the amphibia and the birds. The methods in the two cases differ fundamentally in that the transplantation in the amphibia is to an embryonic region, i.e., a region which will subsequently form a part of the larva, while in the case of the bird, the transplantation is ordinarily made to the region of the chorio-allantoic membrane which obtains an early differentiation and a differentiation which contains no structures characteristic of the embryo itself. The transplantation in the latter case, therefore, is to an indifferent tissue with respect to embryonic organs. The experiments differ in still another respect. On the amphibia the transplantations may be made between embryos of any age while on the chick, the grafts develop most successfully when the host age is between seven and one-half and nine days. In tests of primordia and portions of the germ, therefore, the amphibian material may be transplanted to a host of the same

age as the donor, while in the bird the host is generally older when the chorio-allantois is the site of the implantation. Recently several investigators, notably Waddington, Joy, and Woodside, have varied the technique of transplantation, and have transplanted tissues directly to the embryonic region using as hosts avian blastoderms of the same age as the donor. Some of their results will be mentioned here and some below in connection with the study of dependent differentiation.

Experiments designed to test the capacity for independent self-differentiation of portions of embryos are of considerable importance in that they give a measure of the degree of differentiation attained by the parts prior to removal from the donor. It is also evident that within limits, the larger the part tested the greater will be the extent of the differentiation obtained. Three types of behavior may be anticipated in a series of tests on any single part according to the age of the donor. If sufficiently old, the development of the part may be that of a mosaic in that the subordinate portions of the part will have progressed so far in their development that the new environment will not modify the fate of the components. If sufficiently young, the transplanted material may cooperate in the development of the typical local structures of the host, indicating that the transplanted material was still in a plastic condition showing no restriction with respect to the special potencies involved. At an intermediate age it is always possible that the restriction of potency would have been initiated and hence that complete cooperation with the host materials would not be possible and yet that progressive changes would not be sufficiently advanced to yield positive differentiation characteristic of the organs of the donor regions repre-

sented. The first two types of behavior are common in such transplantations; the third is more difficult to detect and is not so common in transplantations to embryonic regions though it may be suggested in tissue cultures and in chorio-allantoic grafts. Analysis is rendered difficult by the fact that differences in the ages of host or the source of the culture medium may modify the expression of the capacities of the transplanted tissues to some extent.

The first embryonic transplantations were carried out between large segments of embryos of the same and different species by Born and by Harrison. Subsequently, the latter investigator employed the method in a study of the development of the lateral line organs of the anura. Many experiments by numerous investigators designed to test the capacity for independent self-differentiation vested in various organ primordia followed. Experiments with optic and otic primordia have been made on both the amphibia and the chick. The names of Spemann, Streeter, Lewis, Filatow, Ogawa, Harrison, Kaan, Sternberg, Dalcq, and Pasquini are associated with the experiments on the amphibia. In the chick, Miss Fell has studied the development of the same primordia in tissue culture and I have made studies of their behavior in grafts to the chorio-allantois.

In the anura, the optic cup and the optic vesicle when isolated and transplanted to a foreign location in the embryo produce a differentiated optic organ. Spemann has obtained the differentiation of "eyes" following the transplantation of localized regions of the medullary plate removed from the donor prior to the appearance of the optic primordia as discrete morphological units. The differentiation obtained demonstrates that the area is a "real"

one in terms of the chemo-differentiation of Huxley. Further experimentation has shown that the two eyes arise from a single medially located primordium and that this appears first with the development of the medullary plate. Transplantations of the region carried out prior to that time yield no specific optic differentiation. In those cases in which the eye was not in contact with the body ectoderm no lens developed. Adelmann has recently shown that even in such cases a lens may eventually develop, presumably from the iridial margin. Whether the lens is present or absent, the differentiation of the optic cup is comparable to that of the host and of the control of the same temporal age. Similar results have been obtained with the urodeles.

In the chick, tests upon the optic cup of the forty-eight hour embryo both in tissue culture and in the chorio-allantoic membrane have shown that the organ is fully "determined" at that time. The same is true of the optic vesicle of the 35 hour stage. The subordinate differentiation attained by the optic vesicle is most striking. Similar subordinate differentiations — though the eyes do not attain as perfect a gross morphology — may be obtained in grafts of the optic region of closing medullary plate stages (5 to 6 somites). Comparable differentiation has also been obtained in tissue cultures by Miss Fell. The experiments on the optic regions of the chick differ from those on similar regions in the amphibia in that in nearly all cases the body ectoderm lying over the optic vesicle was included in the transplantations.

Transplantations of the otic region do not show as close a gross morphological similarity to the organ of the control as do those of the optic primordia. This appears to be due to

the fact that the mechanical conditions in the graft do not permit the expansion of the vesicular regions. Sternberg has obtained nearly normal ears by transplanting the primordium to the neck region of the amphibian. In spite of the morphological distortion of the organ, however, subordinate differentiation may be relatively complete. Harrison, Kaan, and others have shown that the history of the subordinate differentiation of the organ is particularly interesting. The segregation appears first as that of the entire organ and later as a mosaic of its component parts. In some respects the development of the otic region is more interesting than that of the eye for it shows more subordinate differentiations. These have yielded considerable information as to the importance of symmetry relations and the time of their fixation in the primordium. For a complete discussion of this question one should consult the papers of Streeter, Spemann, Kaan, and more recently and in greater detail those of Harrison. The situation is similar in many respects to that encountered in the development of the limb (see especially Harrison and Swett). It has been shown that the membranous labyrinth of the ear will develop from the appropriate region of the ectoderm when this is isolated even in the placode stages of the amphibian germ. Similar experiments upon the placode of the embryo of the chick have not yielded comparable results in that the piece of tissue transplanted is apparently too small to survive and to yield grafts which are recoverable.

The behavior of optic and otic primordia transplanted heteroplastically has been examined in some detail by Harrison and several of his students, notably Twitty, and Twitty and Schwind. The results point, as do those on the limb, to an independent

self-differentiation not only as to morphological and histological differentiation but in respect to the growth rates as well.

Similar studies on the independent self-differentiation of other primordia of the embryo such as the balancer, the sucker, the gill, the heart, the nephros, parts of the nervous system, the nasal region, etc., have yielded remarkably uniform results. When those obtained from the transplantation of segments of the embryo are compared, however, considerable variation is encountered. This is due to the fact that there is a variation in the manipulation of the material and the methods of transplantation. It should also be constantly borne in mind that the statement that isolation precludes further embryonic segregation applies not to the systems included within the isolated piece of the embryo but to those processes which depend for their completion on the influence of other portions of the embryo upon the isolated piece. For the purpose of the analysis, therefore, isolated segments of the embryo may be considered as primordia.

The most complete analysis of the capacities of the various presumptive germ layers of the amphibian gastrula and late blastula is to be found in the experiments of Mangold upon the embryos of the axolotl and of *Triton*. By means of transplantations from donors of various ages he has determined that the ectodermal and the mesodermal areas of the germ are very plastic in their potencies up to the time of gastrulation, i.e. show little embryonic segregation. Shortly after the initiation of gastrulation there is evidence of some restriction and by the time the process is completed, the restriction has progressed so far that the implanted tissues develop consistently by independent self-differentiation.

The cooperation of the implanted tissues in the development of organs of the host according to their eventual position within the host Mangold calls "positionally imposed development" (ortsgemässe Entwicklung) which in turn implies dependent development and an absence of genetic restriction. The results of these experiments are particularly clear in the case of *Triton* since Mangold employed two species in the experiments, one pigmented and one without pigment, and the source of the tissues could be followed very exactly.

The reality of the conception of dependent development had been apparent from early experiments of Roux in which one of the first two blastomeres was killed with a hot needle. It was also apparent in the early partial isolation experiments on the *Triton* egg by Spemann and in the defect experiments of Brachet. The first clearcut example of a causal relationship, however, was found in the dependence of lens development upon the presence of the optic cup demonstrated by Lewis and by Spemann. Body ectoderm transplanted to the region over the optic vesicle developed as lens, and optic vesicles transplanted to foreign locations, when adjacent to body ectoderm, caused lens to develop from that ectoderm. Not all species of frogs behaved in this fashion in that the region from which the lens can be formed is more or less restricted in some of the species. Conversely, lens did not develop in the absence of the optic vesicle in most of the species studied (exception *R. esculenta*). The relation here has been studied in considerable detail by Filatow. Spemann and Lewis have both demonstrated, however, that the relation in most of the species is a causal one and that the development of the lens placode

is induced in some fashion by the optic vesicle or cup.

Subsequent investigations of other organ structures by a large number of workers indicate that many causal relationships can be described in the developing embryo, some of which are more or less local and others of which are much more general. Among the latter may be mentioned the effect of the thyroid secretion on sensitized cells of the embryo at the time of metamorphosis. This has been described in relation to the resorption of the gills by many workers. Helff has made a general survey of the metamorphic changes in many other body tissues and organs.

As a result of a painstaking analysis of the properties of the parts of the early gastrula and late blastula, more especially those related to the region of the blastopore which had been carried on by Spemann and his students, Spemann and Mangold ('24) described what they termed an "organization center" located in the dorsal lip of the blastopore of *Triton*. The argument leading to this conclusion may be summarized as follows. Transplantation experiments show that the first region of the embryo to become "determined" is that in the dorsal lip of the blastopore which gives rise to the notochord and its related structures. This occurs in the earliest stages of gastrulation. Rotation of the animal half of the early gastrula has no effect on the orientation of the embryo within the gastrula. The transplantation of a small fragment of the dorsal lip of the blastopore is known to result in the formation of embryonic regions in excess of those which might be anticipated from the region transplanted. The last point is of primary significance for it indicates that the transplanted material influences the development of the surrounding tissues and coordi-

nates their activities. The actual extent of the participation of the transplanted tissue may be discovered by using a host and a donor of different species with different pigmentations or by employing as a donor a gastrula which has been stained with a vital dye. When this is done it is found that the dorsal lip material of the donor actually develops by independent self-differentiation and that by far the greater part of the secondary system is composed of the tissues of the host. In other words, the donor has supplied a center of differentiation around which the tissues of the host are organized and so organized that they supplement the differentiations of the implant to yield a typical larval axis. The point of initiation of gastrulation, *i.e.* the position of the dorsal lip of the blastopore, is located in the central region of the grey crescent of the anuran blastula and in a similar region of the urodele embryo, which is not so clearly delineated in its pigmentation. Mangold and Seidel ('27), however, have carried on experiments with fused two-cell stages of the *Triton* egg the results of which lead to the conclusion that a similar predelineation of the future gastrulation site is present in the urodele egg even at the two-celled stage. The actual properties of the gastrulating materials would appear to be fixed during this process for Spemann has shown that materials which under the normal circumstances never gastrulate can acquire these properties and subsequently act as organizing regions if they are placed in the region of gastrulation and are allowed to remain there for a short time. The actual extent of the center of organization has been determined by Bautzmann ('26). It is interesting to recall that the area comprises that which subsequently undergoes involution and which is that of the presump-

tive mesoblast and notochord of the larva.

Mangold has shown, as has been mentioned above, that during the earlier stages of gastrulation materials from the ventral ectodermal and mesodermal regions of the gastrula show "ortsgemässe Entwicklung" following transplantation. Their behavior is similar in relation to the transplanted organization center. It would appear, therefore, that the two experiments are similar and that transplantation of a portion of the blastoporal lip is tantamount to the transplantation of all of the surrounding host areas, *i.e.* that the host areas actually behave as transplanted materials. Lehmann and others have shown that the extent of the influence of the implanted dorsal lip decreases as the distance from the marginal area of involution increases, and that the head ectoderm is least affected by the presence of the organization center. The activities of the center during gastrulation are capable of description in terms of a transformation of the symmetry of the embryo and hence of the introduction of secondary differentials and relations within the embryo itself. Some of these relations may be shown to be essential to the inductive processes which follow.

The initiation of gastrulation in secondary centers in the early gastrula of the amphibian embryo is followed by inductive processes similar to those which are active in the host axial region. These result in the restriction of potencies within the involuted tissues and the induction of the medullary plate in the overlying ectoderm. While the word "induction" was first employed for the latter activities, the term suggests a determinative action of the causal agent which is not implicit in the results of the experiments. Waddington's term, "evocation", is

preferable in that it implies a specificity resident in the responding system which in turn determines the nature of the response. The justification for this statement is to be found in the fact that the differentiations of secondary embryos which develop following the implantation of portions of the dorsal lip of the blastopore accord with those of the primary (or host) axis in terms of level of differentiation. It would appear, therefore, that the host has some control over the type of development which takes place, though the presence of development of any kind is attributable to the initial activity of the implant itself. Furthermore, several kinds of tissues when implanted have been shown to be capable of initiating medullary plate development from body ectoderm of the gastrula. This suggests the evocation of a potency or the initiation of a segregation of potencies within the ectoderm. It has also been shown that the segregations change in their nature according to the time at which the evocation takes place. This is very evident when the times of evocation of lens, gill, balancer, and medullary plate are compared. The same change in segregation state may also be involved in the homoeogenetic induction postulated by Mangold and by Spemann. These investigators found that when optic primordia are transplanted to the blastula cavity of the early gastrula of *Triton*, the overlying body ectoderm responds by the formation of medullary plate. Since the inducing region is a nervous tissue genetically related to the tissue induced, they described the action as that of homoeogenetic or assimilatory induction. There is a second interpretation which stresses the specific nature of the responding tissues rather than the inducing agent. The argument follows. The optic vesicle ordinarily

calls forth the formation of lens tissue from the body ectoderm. This takes place, however, at a specific stage in the life history. The characteristic response of the body ectoderm during the period of gastrulation is the formation of the medullary plate. If we assume, therefore, that the interpretation should involve both the competence of the optic cup as an inducing region and the competence of the body ectoderm as a responding system, we must conclude that the formation of a medullary plate rather than a lens by the ectoderm of the gastrula is to be attributed to the nature of the response characteristic of the ectoderm at that time and not to any specificity of the inducing agent or to homoeogenetic action. A similar situation which is perhaps clearer is encountered in the behavior of body ectoderm in hetero-specific transplantations between anurans and urodeles as described by Spemann and by Schotté. Body ectoderm of an appropriate age, transplanted from an anuran to the mouth region of a urodele, responds by the formation of mouth organs which are the mouth structures of the anuran (the donor) and not of the urodele (the host). Conversely, ectoderm transplanted from urodele to anuran produces structures which are of the urodele type.

It will be noted that the majority of the inductive phenomena which have been described exert their effects during the earlier developmental stages. It must be assumed, however, that similar processes are characteristic of more advanced stages and, in fact, there is some experimental evidence that this is the case. In several systems which remain in "open term" (Lillie) during late larval stages or even into the adult period, it may be shown that causal relations similar to those of induction are responsible for

the development of organs. This has been demonstrated by Parker and his students for the lateral line organs of fishes. The initiation of the differentiation is due to the presence of a substance secreted by the nerve fiber. The maintenance of the differentiation Parker attributes to the presence of a trophic material supplied by the nerve. In the catfish, *Ameiurus*, Miss Bailey has shown that lateral line organs are formed by the epidermal tissues generally and in response to the presence of the terminal ends of cut lateral line nerves. In the goldfish, the same worker has shown that lateral line organs are regenerated only when the nerve is present and only from a special kind of epidermis, *i.e.* of the lateral line canal. Similar inductions which demonstrate the specificity of the differentiating region are well illustrated by the experiments on *Triton* carried out by Locatelli, and by Guyénot and his students. Limb nerves redirected so as to lie in the region of the tail induce the formation of an accessory tail bud; in the region of the limb, accessory limb; and in the region of the dorsal crest, an accessory crest.

While the power of organization or individuation (Waddington) is lost with the death of tissues previously possessing that property, the same is not true of the capacity for evocation. Numerous experiments by Spemann, Fischer, Weh Meyer, Woerdemann, Holtfretter, Hatt, and others have shown that this capacity is retained by tissues after killing by means of heat or freezing; that it is retained through the processes of fixation and imbedding for sectioning; that it is possessed by tissues from various sources and by tissues from a variety of animals; and that, while not detectable in the living uncleaved amphibian egg, it appears after heating the egg to over 100°C.

for a short period of time. The non-specificity of the action is apparent from many of the experiments as is well illustrated by Hatt's observation that killed primitive streak of the chick blastoderm is effective in inducing medullary plate formation in the amphibian gastrula. It is only natural, therefore, that an effort should have been made to locate and identify the substance responsible for induction. After preliminary experiments of a chemical nature by Fischer and Wehmeyer, Holtfretter, Woerdemann and others, Waddington and the Needhams, and more recently Waddington, Needham, Nowinski, and Lemberg have identified the substance as fat soluble and probably a sterol. The present indications are that it is in some way related to the phenanthrenes and the female sex hormone, oestrogen. Some of the synthetic carcinogenic substances which have been employed in efforts to obtain inductions in the amphibian germ have yielded some measure of success.

It is apparent from the above argument, I believe, that the processes involved in differentiation and those which are concerned in induction or evocation belong to different categories. This has been recognized by Waddington in his distinction between evocation and the individuation field. The cooperation which is seen between the implanted organization center and the host tissues in the formation of the axial structures of the secondary embryo is the result of both types of activity. Insofar as the initial activation of the involution in the cells surrounding the implanted blastoporal region is concerned, the activity is morphogenetic, the involution capacity apparently being assumed by the relatively inert cells of the surrounding tissues through their association with the highly active cells of the trans-

planted lip region. The secondary alterations in the fates of the involuting cells is through an inductive process similar in every respect to that which is characteristic of the normal process in the host or control. The evocation of the medullary plate and its subordinate parts as well as the subordinate development of the components of the involuted material is under the control of the individuation system of the host (see above). The induction calls forth a response in the embryo, but the nature of the response is dependent upon the relation of the part to the whole. The relation has been pictured in a variety of ways,—in terms of an axial metabolic gradient and subordinate gradients by Child, in terms of differential activities of a less specific nature by myself, in terms of differentials in special capacities by Runnström and Hörstadius, and more recently in terms of similar gradients in potencies and distribution of materials by Dalcq and Pasteels.

In many respects the activities of organization may be likened to the morphogenic processes described above while those of induction may be said to involve critical periods in histogenesis. It is an interesting fact that at all stages in development morphogenetic processes often are associated with condensations or accumulations of cells into groups with similar potencies and in the unsegmented ovum the accumulation of materials of similar kinds in restricted portions of the germ. In the later stages, this is to be seen in the segmentation of the mesoblast, in the segmentation of the neural crest material, and in the condensation of the materials of the germ to form the axial embryo. Similar processes may take place in the development of pattern in numerous primordia. Such is the case in the subordinate differentiation of the

nephroi and in that of the cartilage patterns of the limbs. When isolated from early limb bud stages the cartilage precursors form simple masses of cartilage; isolated at a later stage, the same region produces several subordinate cartilage masses. When taken from still later stages, the isolated cartilage-forming material develops as a series of foci, these foci showing morphological relationships comparable to those in the control. Such morphogenetic segregations illustrate a common process which I have chosen to speak of as morphochoresis and play an exceedingly important role in the development of pattern in the embryo. At the same time, they are relatively unimportant in respect to the histogenetic activities of the system.

In the vertebrates which we have considered above, the histogenetic activities of the embryo appear to be dependent upon three factors, *viz.*: the production of an evocating or activating substance by the stimulating part, the sensitization of the cells of the responding system to the evocating substance (competence of Waddington), and the correlation in time of the production of the evocating substance and the competence of the tissues of the responding system. Defective development may be accounted for on the basis of defects in any one of the three. There is ample experimental evidence to show that the period over which the evocating substance is produced by specific tissues is limited. It appears, however, that it is not as closely limited as is the condition of competence in the responding tissues. It has been demonstrated that the type of competence of the responding system is constantly changing. It follows, therefore, that an understanding of the meaning of differentiation is to be obtained only through a complete analysis of the properties of the components of

the responding system and a knowledge of the importance of each step in the previous history of these components to the attainment of specific competence. While the descriptions should, if possible, be in both biological and in

chemical and physical terms, we must not be discouraged if the solution of the problem resists physical and chemical interpretation, for differentiation is, in the ultimate analysis, a biological phenomenon.



The Organized Forms of Chromatin

By JOHN W. SAUNDERS*

In reviewing the literature pertinent to nuclear cytology, controversial issues arise in the interpretation of the various chromatic structures present in the nucleus. The purpose of this paper is to analyze and correlate the work of recent investigators which bears on these matters.

The Spindle Fibers.—Early cytologists, Strassburger, Van Beneden, Boveri, and their contemporaries agreed on a cytoplasmic derivation of the spindle fibers, but differed in details. Some recent works show that in many organisms these conditions of origin do not obtain. Contrary opinion has been well illustrated by the work of Carothers ('36) on acridian chromosomes. Her findings indicate the origin of the fiber from the chromosome itself which it seems to connect with the centriole. Franz Schrader ('35) reported a somewhat similar case in meiotic divisions of the X-chromosome of *Protenor* which gives rise to multiple spindle fibers. Hughes-Schrader ('40) found spindle fibers in the germinal tissue of the coccid, *Llaveiella taenechina*, which are formed from the sheath or pellicle of the chromosomes. These examples present a condition in which the chromatin is related to spindle fiber formation, quite in contrast to the cytoplasmic constitu-

tion of these structures as earlier described.

Spindle fibers such as those just mentioned have no specialized differentiation at their point of attachment to the chromosome. It is desirable, also, to discuss the kinetochore, the point at which spindle fibers are affixed to the chromosomes in other organisms. Schrader ('36) described for the chromosomes of the germ cells of *Amphiuma tridactylum* a shallow achromatic cup, in the notch of which is a tiny chromatic spherule to which the spindle fiber is attached. Cup and granule he called the kinetochore. He observed two of these cups in early diakinesis tetrads, each with its own spherule, and each associated with a different pair of chromatids. In late diakinesis the chromatic spherules were observed to be compound and to remain so until the interphase, whereupon the kinetochores disappear. They reappear during the second maturation division, at which time there is a single kinetochore and spherule per chromatid.

Lorbeer ('34), on the contrary, considered the kinetochore to be "... a chromomere exactly like any other chromomere." Nebel ('39) described it as being composed, not only of those elements reported by Schrader, but perhaps of chromatic connections with the chromonemata. In addition, each

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chromonema has potentially its own kinetochore, but the majority of workers have held that as long as several chromonemata are held together by one kinetochore, it is unsplit. In this same paper Nebel stated that "each chromosome, to be functional, apparently requires a kinetochore." Thus, the term is used to include all types of attachment regions. Exceptions to his statement must of course be made for cases in which no fiber attachments are demonstrable and for those in which the fibers originate as a part of the chromosomal substance.

Schrader ('36), studying the nature of the kinetochore, found that it resists decolorization markedly as compared with the rest of the chromosome. He observed, too, that after treatment with Benda's stain for mitochondria the kinetochore in chromosomes of *Amphiuma* is stained violet, as are the mitochondria, in contrast to the brown color of the chromosomes proper. In the gonads of *Episthocanthus elatus* (prepared by Wilson) he observed that the kinetochores and the centrioles stain almost equally.

Since recent investigations (see Metz, '33; Schrader, '35; and Scott, '36) have established a distinct morphological differentiation of spindle fibers, it seems that it should be possible to demonstrate some function correlated with their apparent action as "traction" (Wilson, '28) fibers. Yet, Carlson ('38) has found that in neuroblasts of *Chorotophaga viridifasciata* the initial separation of metaphase chromosomes is autonomous, a view shared by Belar, Bleier, Schaede, and Schrader. He found, in addition, that in the anaphase configurations of neuroblasts in which fragmentation was artificially induced by X-ray treatments, the fragments without spindle attachments, divided and initiated separation at the same time as did the others, but in a posi-

tion outside the spindle. During late anaphase these fragments entered the spindle, but did not come into close association with the other chromosomes during telophase.

Schrader ('35) has observed that in the spermatid-forming divisions of *Protenor*, the X-chromosome is attached at both ends and lies in a position parallel to the axis of the spindle. Yet it does not divide at the metaphase of this division and passes entirely to one pole. More recently Hughes-Schrader ('40) observed that in the second meiotic anaphases of *Llaveiella* the halves of the X-chromosome move to opposite poles with no sign of attaching spindle fibers.

Further evidence of the independence of chromosomal movement is to be found in the work of Metz ('33) and in that of Scott ('36). The former, studying monocentric mitoses in *Sciara*, has seen that the daughter chromosomes formed in these divisions move away from the single centriole in spite of the resistance of spindle fibers from that body. That the fibers offer hindrance is evidenced by the attenuated condition of the ends of the chromosomes to which they are attached and with which they appear to be continuous. Metz offered the hypothesis that the movement of the chromosomes is effected by something integral within their constitution which causes a progressive solution of the cytoplasm in the direction of their movement and a corresponding gelation behind them.

Scott ('36), studying the abortive monocentric first spermatocyte divisions of *Micromalthus debilis*, found no indications of attenuation such as were observed by Metz, but rather, a progressive lengthening of rather rigid spindle fibers which became visible only when the chromosomes were well

on their way towards the opposite periphery of the cell.

From the evidences presented by these researches, the conclusion must be drawn that the spindle fibers do not, in all cases, have anything to do with the movement of the chromosomes to the poles.

An interesting contrast might be made at this point between the observations of Carothers ('36) and those of Metz ('33). The former present evidence for the belief that the chromosomes move to the poles by the resorption of that part of their substance which enters into the formation of the spindle fibers. Metz's drawings, while not so conclusive on the origin of the fibers, present good evidence that they are at least continuous with the peripheral matrices of their chromosomes. In spite of this apparent similarity the acridian chromosomes studied by Carothers move in the direction of the pole to which they are attached, and those of *Sciara* move in the opposite direction.

Interzonal Fibers.—Controversial interpretations of interzonal fiber structure are also to be found in the literature. Modern work has shown that their nature is much the same for different organisms. The Schraders interpreted the interzonal connections seen in *Amphiuma*, *Protenor*, and *Llaveiella* chromosomes as representing a tubular attenuation of the metaphase sheath. Carothers, on the other hand, interpreted these connections as solid continuations of the chromatin of the separating bodies. Possibly both viewpoints are correct if the chromatin pellicles involved in the Schraders' material are heavier and more elastic in comparison with the matrix proper than are those of Carothers' acridian chromosomes (see F. Schrader, '35, Figs. 8, 9, 14, 15; Carothers, '36, Figs. 16-23; Hughes-Schrader, '40, Plates I

and II). My own observations of the chromosomes in acridian testes support the conclusion of Carothers.

Chromonemata and Matrix.—Chromosomes have been reported to be made up of spirally coiled chromonemata imbedded in a matrix whose outer layer is a firmer or more tenuous sheath. A chromonema consists of a series of chromomeres linearly arranged along a chromatically staining strand. This structure is usually visible as such only during the prophase. Much of the recent research upon the structure of chromosomes has been concerned with the determination of mechanical relationships within them, but the interpretations of the results have unduly restricted the activities of chromonemata mechanically. Perhaps it is sufficient to conclude that the matrical pellicles contracting about expanded chromonemata, which are restricted as to the movement of their ends, may produce the configurations of coiling.

Most modern workers still consider the somatic chromosomes to be bipartite from anaphase to prophase, and then four-parted until metaphase (see Atwood, '37; Creighton, '38; Geiller, '38; Gates, '38; Nebel, '39; etc.), in spite of evidence presented by Sharp ('34), Kuwada ('38), Carlson ('38), and Levan ('39) that chromosomes are four-parted from anaphase to prophase. Nebel and Ruttle ('36) have reported that in the grasshopper, *Dissosteira carolina* and in *Tradescantia reflexa*, *Hordeum vulgare* and *Secale cereale* the chromosomes are four-parted at the metaphase in somatic mitoses. That multiplication of half-chromatids takes place at metaphase has been conclusively demonstrated by these same investigators. In correlation with these facts, they have observed that in the organisms studied, the leptotene threads are tetravalent, and synapsis

produces eight-parted chromosomes. Metaphase multiplication produces a chromosome with sixteen demonstrable chromonemata which separate into eight-parted dyads at the initiation of anaphase. During the second division no multiplication takes place and the gametes are formed with chromosomes of a quadrapartite structure.

Hughes-Schrader ('40) has observed a "tertiary" split in the chromosomes of *Llaveiella*. In this coccid, the whole of the chromosomes and their matrices are already definitely split along three planes at the metaphase of the first division. Their sheaths, as they separate at differential rates, frequently fuse to form a continuous tube within which the chromosomes move to the pole.

The behavior of the matrices of the chromosomes during the periods of multiplication and separation of chromonemata has been somewhat hard to define. Sharp ('29) found in *Tradescantia virginiana* that "... respective matrices of two sister chromosomes separating in the anaphase are defined at the end of the immediately preceding prophase, whereas their respective chromonematic constituents are defined by a division in the second preceding prophase." Nebel, ('39) reported that "matrical pellicles may, ... hypothetically at least, be present in multiples, a chromosome pellicle enclosing two chromatid pellicles, for instance." According to this hypothesis, then, it may be possible to maintain that in organisms of the chromonematic constitution of *T. reflexa*, *Hordeum vulgare*, *Secale cereale*, and *Dissosteira carolina* the matrix surrounding the separate daughter chromosomes in somatic divisions surrounds four chromonemata, each pair of which has its own pellicle.

Salivary gland chromosomes are considered to picture the ultimate point

to which the actual nature of the genonema, or gene string, may be demonstrated cytologically. Painter ('39) described their origin in *Simulium* from the synapsis of two bivalent, leptotene-like threads which were observed to grow and reduplicate their chromomeres and connecting strands, forming characteristic band patterns across the diameter of the chromosome. His researches indicated that the connecting strands seen between chromomeres on a single chromonema are compound, and that the chromonemata may be made up of many homologous ultimate genonemata. The chromomeres themselves he considered to be coiled portions of the ultimate gene strings. Muller ('35) homologized the chromonemata to single, uncoiled, prophase chromosomes. If this homology obtains, it seems plausible to conclude that perhaps normal mitotic and meiotic chromosomes are also made up of very many strands, and that they may be capable of demonstration by the use of proper technique.

Resting Nucleus.—In the light of the proved genetic continuity of chromosomes, the chromatin must have a definite organization throughout the interphase as well as during the definitive activities of the mitotic and meiotic cycles. The linear order of the genes on the chromonemata must be maintained throughout the resting condition of the nucleus. There have been several accounts of nuclear structures during interphase which, while giving evidence of chromosomal continuity, are not in keeping with the occurrence of chromonemata as they are ordinarily understood. Wilson ('37, pages 890-901) mentions accounts of three types of resting nuclear formation: (1) alveolation, in which the resting nucleus is formed by a process of telophasic branching and alveola-

tion of the chromosomes; (2) vesicle formation, in which the chromosomes become enclosed in separate vesicles during the telophase; and (3) formation of the interphase nucleus by a decrease in the chromaticity of the matrices of the double chromosomes as their constituent chromonemata separate somewhat during the anaphase. In only the last of these is the actual presence of chromonemata in the resting nucleus visualized, yet it may be possible that all three types represent different aspects of the same fundamental structures. Perhaps the chromonemata involved in the formation of vesicles and alveolar structures lose their chromaticity in the telophase so as not to be recognizable while the reticulum of the resting nucleus is being formed. If this is the case, nuclear re-formation at telophase is much the same in all three types. In addition, however, we must consider that vesicles are formed by chromosomes whose sheaths are more stable than those of other kinds, and which are distended by the entrance of fluid from the cytoplasm as their matrical material forms a reticular network. For more recent investigations of these phenomena see Gregoire ('32), Roosen-Runge ('38), Cooper ('39), Sharp ('29, '34), and McClintock ('39).

Nucleolus.—Many recent observations give evidence that nucleoli furnish matrical material to developing prophase chromonemata. In addition, numerous investigators have found that nucleolar like bodies (*karyosomes* of Wilson) develop on definite chromosomes within a complex and on certain definite regions of those chromosomes. McClintock ('34) has demonstrated that the "satellited" region in nuclei of *Zea* is located on chromosome VI. This region may undergo crossing-over, translocation, and other phenomena associated with intra- and inter-

chromosomal alignment. In addition, she has observed "... that a chromosome complement deficient for the region of chromosome VI which includes the nucleolar-organizing body will produce a nucleus with many small nucleolar-like bodies ...," and that "... if a normal nucleus is not produced through the functioning of a nucleolar-organizing element, nuclear substance produced in each chromosome will accumulate in nucleolar-like droplets along the chromosomes."

Thus the supposition may be derived that the nucleolus is a kind of storehouse of the nucleic acid radicals which give to the chromosomes of the active mitotic stages their basichromatic reaction. Perhaps the oxyphilic reaction of the chromonemata and reticulum of the nucleus in the interphase may be due to the complete satisfaction of the affinities of the nucleic acid radicals by an increase in the quantity of protein bases. The formation of hypotheses such as these, however, makes the interpretation of other staining affinities far too involved, and we shall have to wait for a further untangling of the mysteries of biochemistry and physical chemistry concerned in chromosome and nucleus formation before we can determine anything definite as to intranuclear activities. So, for the present, we can conclude only that all of the chromosomes give off material during the telophase, and under normal circumstances this material is incorporated in typical nucleoli formed in association with specialized regions of certain chromosomes.

Summary.—(1) In contrast to older conceptions of the origin of spindle fibers from cytoplasmic constituents, they recently have been reported to arise from the chromosomes themselves as a part of their chromatic material.

(2) In other reported cases the point of spindle fiber attachment is a differentiated region called the kinetochore.

(3) Spindle fibers are not demonstrated to act as "traction" fibers in cell division. At the most they only act as regulatory differentiations in the course of mitosis or meiosis.

(4) Workers are not agreed on the number of chromonemata involved in the make-up of a single chromosome throughout its cycle of activity.

(5) Investigations which have shown different methods of the maintenance of chromosomal individuality during interphase may represent different interpretations of the same fundamental structures.

(6) No definite proof of function can be assigned to the nucleolus.

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Chapter News Letters

Beta

—University of Michigan

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Vice-President—Leonard Allison, 1054 S. Main, Ann Arbor, Michigan.

Secretary—Reed W. Varner, 816 E. Kingsley, Ann Arbor, Michigan.

Treasurer—Betty Robertson, 411 N. Division, Ann Arbor, Michigan.

At the time this news letter is being written the organization of the program for Beta is just getting under way. An executive meeting has been held at which new officers were instructed in the more esoteric machinations of the society by their more experienced predecessors. The dates of the meetings for the year were decided upon and speakers were tentatively selected.

Since Beta has not had a purely social gathering in recent years, it was decided to plan a picnic or steak roast for October 23 at Dexter State Park. Plans for this will be made at the first business meeting on October 9. Everyone seems to be in favor of the idea, and all feel that it will serve as an excellent "ice breaker" for both old and new members.

Since this year is Beta's silver anniversary the members and officers are especially anxious to have a banner year. We are planning to renew our series of open meetings designed primarily to stimulate interest among undergraduates in biological fields and to point out exciting possibilities of research. These meetings have attracted large numbers in the past and should continue to do so.

BETTY M. ROBERTSON, *Secretary*.

Epsilon

—University of Denver

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Vice-President—James Miles, 1002 S. Ogden, Denver, Colorado.

Secretary—Byron Miller, 2501 High, Denver, Colorado.

Treasurer—Harry Durham, 1939 E. Evans, Denver, Colorado.

Zeta

—University of Wisconsin

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Treasurer—T. W. Conger, Biochemistry Bldg., University of Wisconsin, Madison, Wisconsin.

Editor—A. I. Coombes, Biochemistry Bldg., University of Wisconsin, Madison, Wisconsin.

Zeta chapter welcomed 13 new members at the spring banquet held at the University Club on May 23. The group was addressed on that occasion by our National Honorary President, Dr. L. J. Cole, whose address was entitled "Generations to Come." The speaker was introduced by Prof. George Wagner of the Biology Department who is one of our honorary members.

With the annual picnic held in the early part of June, our activities came to a close for last year.

For the first meeting this year Zeta Chapter is going to have a rare treat, because we are being addressed on that occasion by Dr. Launcelot Hogben, well-known author who is here on our campus on leave from the University of Aberdeen. He has chosen as his theme—"This Animal Called Man."

A. IRVING COOMBES, *Editor*.

Eta

—University of Akron

President—George Anastos, Biology Dept., University of Akron, Akron, Ohio.

Vice-President—Betty J. Frick, Biology Dept., University of Akron, Akron, Ohio.

Secretary—C. Richard Weaver, Biology Dept., University of Akron, Akron, Ohio.

Treasurer—George H. Twickler, Biology Dept., University of Akron, Akron, Ohio.

At the June 1940 meeting, the following who had been pledges and had completed some portions of their research problems, were elected to membership: Walter Fair, Richard Lockhart and Richard Weaver. Four other biology students who had completed their requirements in early spring were elected to membership in March. Those were William Baird, Betty Frick, Robert Burton, and William Rogers.

The chapter has lost a larger number of advanced students than usual, but all these have gone into advanced work elsewhere.

Fred Glenny, '36, who received his M.S. in June '40, is now a graduate assistant in the biology department at Western Reserve University starting work towards his doctorate in vertebrate anatomy.

Sam Caplin, who finished his M.S. requirements this summer, has gone to the department of botany at Chicago University to begin work on the doctorate.

Robert Hare, who also completed most requirements with a thesis in zoology, has received an assistantship at State College of Washington in the botany department, and is starting work on his doctorate.

Bill Barkley, zoology major, '40, has started graduate work in anthropology at the University of Chicago.

Four students have entered medical school this fall: Raymond Barrett, at Western Reserve University; William Baird, Ohio State; William Rogers, Maryland; Robert Burton, Meharry Medical College.

The 1940 Phi Sigma Medal of Eta chapter was awarded to Fred Glenny.

In Akron there was recently established the Knight Memorial Fund. Twenty-eight recently graduated college students were selected by the sponsors of the fund on the basis of scholarship, need, and specific plans for graduate work this fall. All selected were of this district, twenty-one Akron University Students, and seven of these were Phi Sigma members: Barkley, Baird, Barrett, Caplin, Hare, Burton, and Rogers.

Coming to the Biology Department as graduate assistant for 1940-1941, is Robert Bryden of Alpha Beta at Mount Union, who subsequently had graduate work in physiology and zoology at Ohio State University.

RICHARD WEAVER, *Secretary*.

Kappa

—University of Kansas

President—Harold Smolin, 607 Snow Hall, University of Kansas, Lawrence, Kansas.

Vice-President—Frank Kalich, Zoology Department, University of Kansas, Lawrence, Kansas.

Secretary—Florence E. Dill, 424 Snow Hall, University of Kansas, Lawrence, Kansas.

Treasurer—Isabelle Baird, 307 Snow Hall, University of Kansas, Lawrence, Kansas.

Kappa Chapter started the year with a short business meeting October 2. Frank Kalich of the Zoology Department was elected Vice-President to fill the vacancy left by Louis Lipovsky, who is now at Washington State, Pullman, Wash.

To reduce the formality of our meetings and also to learn more about student research, each of the departments represented in the society will be responsible for a meeting sometime during the year. We are hoping that students as well as faculty members will present papers through this method.

Members of the Bacteriology Department will present the program for our next meeting, October 16.

FLORENCE DILL, *Secretary*.

Lambda

—Montana State University

President—Allen Chesbro, 432 Eddy Avenue, Missoula, Montana.

Vice-President—Eugene W. Elliott, 325 University Avenue, Missoula, Montana.

Secretary—Jean Krebsbach, 538 Eddy Avenue, Missoula, Montana.

Treasurer—Robert Bowman, 737 Beckwith Avenue, Missoula, Montana.

Members elected in the autumn quarter were initiated February 20. After the formal initiation the group drove up the Blackfoot River to the Happy Bungalow for a banquet at which Dr. Herald Cox was the principal speaker. Those initiated were Fay G. Clark, Professor of Forestry; Irvin V. Anderson, head of Wildlife Research, Region I of the United States Forest Service, at Missoula; Ruth Weise, Bacteriology; Stanley Ames, Chemistry, Mathematics, Bacteriology; Jean Krebsbach, Bacteriology; Mary Shull Lemire, Botany; Home Economics; Willard Olson, Forestry, Range Management; Lester Colby, Wildlife Technology, Journalism.

The spring initiation was held May 26. Following the initiation the chapter went up the Rattlesnake Valley to the Power Park for a picnic. Those initiated were Dr. Charles F. Deiss, Professor of Geology, as an honorary member; Bruce Armstrong, Pre-Medic; Kenneth Boe, Forestry; Merritt Burdick, Forestry; William Cobban, Paleontology; Rae C. Greene, Botany; John Lindberg, Forestry; Thomas McKee, Botany; Emily Louise Marlow, Bacteriology; Joe Mast, Range Management; Roy Myklebust, Zoology; Boyd Price, Range Management; John P. Robinson, Range Management; Merle Rognrud, Wildlife Technology; Walter Shaffner, Range Management; Leonard Smith, Botany; Walter Sundell, Forestry; John Wiggenstein, Bacteriology, Chemistry, Mathematics.

Of particular note among those elected to active membership last year were: Lester A. Colby, who, before returning to the University here to complete his degree in zoology and journalism, was director of the National Wildlife Federation, chairman of the Conservation Committee of the United States Junior Chamber of Commerce, president of the Associated Conservation Organizations of Illinois, president of the Izaak Walton League of Chicago, and formerly assistant to "Ding" Darling when he was president

of the National Wildlife Association; and Irvin V. Anderson, head of Wildlife Research of Region I of the forest service and who has been engaged in National Forest Administration for eight years and for twelve years a research worker in Forest Products and Economics.

The three honorary members of the chapter are: Dr. Wm. G. Bateman, Professor of Physiological Chemistry and adviser of premedics in Montana State University; Dr. Herald Cox, in charge of *Rickettsia* culture and immunology at the United States Public Health Service's Rocky Mountain Laboratory at Hamilton, Montana; and Dr. C. F. Deiss, Professor of Geology and Paleontology at Montana State University, who is actively engaged in research on Cambrian stratigraphy and faunas, particularly the trilobite faunas. Dr. Fred Barkley, national Vice-Chancellor, Curator of the Herbarium and Instructor in Botany, is continuing his researches toward a monograph of the Anacardiaceae.

The faculty members have been engaged in various activities along with their teaching. Dr. M. J. Elrod, Professor Emeritus of Zoology, who has been seriously ill for the past several years has delighted us in showing marked improvement in health and has the cordial wishes of Lambda chapter; Dr. George Finlay Simmons, President of the University, is continuing his research in endocrinology as he gets time from his administrative duties; Dr. J. W. Severy, Vice-President of the University, Chairman of the Division of Biological Sciences and of the Botany Department is doing research in Wildlife; Dean T. C. Spaulding of the Forestry School is doing work in Forest Administration; Dean C. E. Mollett of the Pharmacy School is working on *Hyoscyamus*; Dr. Gordon Castle, Chairman of the Zoology Department is doing research on termites and aquatic invertebrates; Dr. Donald Hetler, Chairman of the Bacteriology Department is working in immunology; Dr. Charles W. Waters, Professor of Botany and Forestry, and Supervisor of the Forestry Nursery, is continuing research in Silviculture and Mycology; Faye G. Clark, Professor of Forestry is doing work in forest management; Dr. J. W. Howard, Professor of Organic Chemistry, is working on the

chemical analysis of the bark of the Douglas fir and is continuing his researches on chloroform and bromoform treated with substituted benzaldehydes; J. H. Ramskill, Professor of Dendrology, is working on the genetic relationships in relation to the morphology of conifer woods; A. E. Atkinson, Professor of Psychology is continuing his researches in experimental psychology; Dr. L. W. Richards, Associate Professor of Pharmacy is working on the Committee on the Revision of the Pharmacopoeia; Dr. John Suchy, Associate Professor of Pharmacy has been working on the hydrolysis of aspirin; Dr. Reuben A. Diettert, Assistant Professor of Botany is continuing his research on the morphology of desert shrubs and trees; Dr. Phillip Wright, Instructor in Zoology, who has just completed his Ph.D. degree at the University of Wisconsin, is continuing his research on coat color of weasels; Dr. Joseph Kramer, Instructor in Botany, is doing research on the ecology of native grasses; Clarence V. Muhlick, Instructor of Forestry and Foreman of the Forestry School Nursery has been doing research on some of the special problems connected with the nursery.

Among the recent graduates from Lambda chapter: Merlin Halterman, '36, is with the State Fish and Game Commission at Roundup, Montana; Royal Turley, '36, is ranger with the Forest Service in Region I; Robert Somerville, '36, is teaching biology at Ventura Junior College; Karl Conklin, '37, is a junior in Rush Medical School of the University of Chicago; Vernon Marsh, '37, is a graduate assistant in zoology at the University of Washington at Seattle; Hervey Sannon, '38, is a junior in Rush Medical School of the University of Chicago; Don Holmquist, '38, is teaching science and coaching at the high school in Saco, Montana; Theodore Walker, '38, received his M.S. in Zoology at the University of Oklahoma this spring and is doing graduate work at the University of Wisconsin; Ben Morris, '38, is enrolled at Cornell Medical College, in New York City; Mary L. Clapp, M.A., '38, is nearly recovered from an accident of two years ago at Chicago University and is continuing studies at the University of Montana; Nancy Lennes, M.A., '39, has been appointed as lab-

oratory assistant in the laboratories for the study of *Rickettsia* diseases in the United States Public Health Service's Rocky Mountain Laboratory at Hamilton, Montana; Joe Linduska, M.A., '38, is in the United States Bureau of Entomology, working at Charlottesville, Virginia; Ann Picchioni, '38, has her Master's degree and is working as pharmacist on the staff of the Cleveland General Hospital; Frank Stanton, '39, holds a two year scholarship at Oregon State College in Wildlife Technology; René Blondeau, '39, is graduate assistant in plant physiology at the University of Wisconsin; George Fritz, '39, is doing graduate work in botany at the University of California at Berkeley; Aloha Hannah, '39, holds a scholarship in zoology and an assistantship in physiology at the University of Oklahoma; Richard Paulson, '39, is a graduate assistant again this year in the department of zoology at the University of California at Berkeley; Oliver Roholt, '39, who was an assistant in bacteriology at Montana State University last year holds a fellowship in bacteriology at Utah State College this year; Merton Reed, '39, who held a scholarship and fellowship at Notre Dame University last year is now a graduate assistant in botany there; Thomas Rogers, '39, is again graduate assistant in botany at Washington State College; Don Lynch, '39, is now doing graduate work at Duke University in forestry; Robert Spicher, '39, is attending medical school at Northwestern University; Jean Loughran, '39, is in the laboratory of Jefferson Memorial College in Philadelphia; Jack Trump, '40, has been awarded a fellowship to the University of Missouri, where he will do graduate work in Wildlife Technology; Stanley Ames, '40, is a graduate assistant in biochemistry at Columbia University; Nancy McGarity, '40, is a graduate assistant in bacteriology at the University of Kansas. Merton Reed and Stanley Ames are in schools without Phi Sigma chapters; after their activity in Lambda chapter, we will expect chapters at Columbia and Notre Dame in the near future.

Among the early graduates from the chapter, news has recently been received from several: Dr. Esther Larson Doak, '26, is working on the vegetation of the New Jersey pine barrens;

Dr. Phillip White, '23, is a special investigator for the Rockefeller Institute in New York City; Paul Lemmon, '29, is nurseryman with the Soil Conservation Service at Pullman, Washington; Fay Foutes, '29, is teaching biology at the Missoula County High School; Chandler Jensen, '28, is with the forest service at Walla Walla, Washington; Joe Lasby, '31, has completed his internship in Minnesota General Hospital and is beginning private practice.

The two faculty members largely responsible for obtaining a chapter of Phi Sigma here, are now at other institutions: Dr. John X. Newman, is head pathologist at the Murray Hospital in Butte; Dr. John G. Owens, is head of the Biology Department of the University of Denver.

During commencement week the following awards were announced for members of Lambda chapter: Phi Sigma Award: Alice Colvin, Bacteriology; Class of 1904 Prize: Eugene W. Elliott, Botany; Duniway Prizes: in Botany, Allen Chesbro; in Bacteriology, Ruth Weise; in Zoology, George Weisel.

Last year meetings were held the first and third Tuesdays of the month. Student talks and guest speakers were about evenly divided. Talks covered the various fields of biology, both pure science and applied biology.

The requirements for election to the chapter have been changed in accordance with the revision of the biology curriculum. Minimum requirements are twenty-five hours in biology with a straight A average, thirty-five hours with a B average, or forty-five hours with slightly below B.

Lambda chapter wishes to express its appreciation to Dr. Keefe for his long and excellent editorship of the *Biologist* and its regret that he has thought it necessary to resign.

JEAN KREBSBACH, *Secretary*.

Mu

—University of California

President—Charles D. Michener, 201 Agriculture Hall, University of California, Berkeley, California.

Vice-President—Isaac L. Shechmeister, 5594 Life Sciences Building, University of California, Berkeley, California.

Secretary—Nathan Stahler, 112 Agriculture Hall, University of California, Berkeley, California.

Treasurer—Elma R. May, 2323 Parker St., Berkeley, California.

Since the University of California begins its academic year in the middle of August, Mu Chapter, at the time of writing, has already had two meetings—both of which were well attended and regarded by all as highly successful.

Our first meeting, on September 4, consisted of a symposium on viruses. About fifty members and guests were present. Professor T. E. Rawlins, of the Department of Plant Pathology, discussed certain physico-chemical properties of these substances, laying particular stress on recent attempts to discover the nature of viruses by use of crystallography. He illustrated his talk with slides showing diagrams of the devices which he is using. The second speaker, Professor K. F. Meyer, Director of the Hooper Foundation for Medical Research at San Francisco and Chairman of the Department of Bacteriology, spoke on the pathology of animal viruses. He reviewed our present knowledge of the biological relationships of viruses to their animal hosts. An interesting discussion followed. The meeting provided a brief but comprehensive survey of the field of virus studies, especially for those who had been unfamiliar with the subject.

The California Museum of Vertebrate Zoology of the University of California was the host of Phi Sigma at its second meeting on October 1. More than fifty members and guests were on hand. This museum contains the largest and best organized collections of vertebrate animals in western America. It has attained this eminence through many years of effort in collecting specimens and a wealth of biological observations concerning them on the part of such outstanding zoologists as the late Joseph Grinnell and E. Hart Merriam. The group was ably shown the collections and facilities of the Museum by Dr. Alden H. Miller, the present Director, Dr. E. Raymond Hall and Mr. Thomas Rodgers. This was our first such open house meeting in recent years. We consider it to have been most successful and plan additional ones for the future.

NATHAN STAHLER, *Secretary*.

Nu

—Washington and Jefferson College

President—Jos. R. Huffschtmidt, Delta Tau Delta, Washington, Pennsylvania.

Vice-President—C. K. McClenathan, 32 Ridge Ave., Washington, Pennsylvania.

Secretary-Treasurer—Wm. McFarland, Phi Gamma Delta, Washington, Pennsylvania.

Nu Chapter closed the activities of last year with a very successful banquet. Our guest speaker for the evening was Dr. Peter Gray, a very eminent worker in the field of experimental embryology from the University of Pittsburgh. We did not initiate any new members last Spring, but are expecting to do so very soon this year.

During the summer two of our members, Walter H. Kasserman and the author, Wm. McFarland, were able to study at the Marine Biological Laboratory, Woods Hole, Mass. This rare opportunity is made possible every year through the Edwin S. Linton Memorial Scholarship Fund.

As for our prospects for this year, we are looking forward to one of the biggest years we have ever had. The campus of our college has been enlarged and the biology department has been moved to new quarters—a large building that was renovated for our use. We now have twice as much room as we had before, plus the addition of some new equipment. Our chapter expects to do its part to make this year a banner year for biology at W. & J.!

WM. MCFARLAND, *Secretary*.

Pi

—Emory University

President — Julian Darlington, 1433 Emory Road, Atlanta, Georgia.

Vice-President — I. N. Hayes, 2154 Boulevard Dr., Atlanta, Georgia.

Secretary—G. L. Mitchell, Jr., Emory University, Atlanta, Georgia.

Treasurer — Pierpont Brown, SAE House, Emory University, Atlanta, Georgia.

Rho

—University of Illinois

President—Kenneth L. Knight, 303 Entomology Building, University of Illinois, Urbana, Illinois.

Vice-President—Jane Claire Dirks, 203 Vivarium, Champaign, Illinois.

Secretary—William G. Gambill, 204 Natural History Building, Urbana, Illinois.

Treasurer—Thomas H. Lord, 362 Noyes Laboratory, Urbana, Illinois.

This year Phi Sigma's twenty-fifth anniversary coincides with Rho Chapter's fifteenth on the campus of the University of Illinois. In recognition of this fact Rho Chapter celebrated at a fifteenth anniversary banquet in May. Thirty new members were initiated, one of the largest groups in the history of the organization. Dr. John T. Buchholz, Head of the Department of Botany and honorary initiate was guest of honor and speaker at the occasion. Other faculty members initiated were Dr. Herman B. Chase, Zoology; Dr. Elizabeth B. Chase, Zoology; and Louis A. Astell, Botany.

Graduate students in the following departments were initiated into active membership: Abe Anellis, Carl De Boer, Richard N. Roerig, Arthur Webb, Glen C. Weber, Robert I. Wise, Bacteriology; Joseph P. Fulton, Nelson L. Lowry, Wilson N. Stewart, Botany; Harry Hoogstraal, Robert Metcalf, Herbert Schoof, Roger Williams, Entomology; Anna Brosnahan, Ben Greenwood, Hugh Hansen, Noel Heyrend, Robert Lam, John Larsh, Betty Leggett, June L. Littrell, Walter Majewski, M. Helen Phillips, Martin Rosoff, Charles Vaughn, Robert Yapp, Zoology.

Rho Chapter opens its yearly activities on October 10 by sponsoring a symposium meeting which has as a theme the discussion of the trend of recent research in three biological fields. Faculty members who will be contributing at this time are Dr. B. V. Hall, Zoology; Dr. Harry J. Fuller, Botany, and Dr. W. V. Balduf, Entomology. By such meetings the chapter hopes better to acquaint its members with some of the problems in which research would be most generally advantageous, in addition to keeping them abreast of the type of work being

done at the present time. Other meetings are planned with the idea of developing better understanding among chapter members of the type of research each is doing. Ultimately it is hoped that this may lead to some degree of cooperation and coordination of graduate research in the biological sciences here at the University of Illinois.

WILLIAM G. GAMBILL, JR., *Secretary.*

Sigma

—University of Florida

President—Nelson Marshall, Department of Biology, University of Florida, Gainesville, Florida.

Vice-President—Wilbur DeVall, School of Forestry, University of Florida, Gainesville, Florida.

Secretary—Coleman J. Goin, Department of Biology, University of Florida, Gainesville, Florida.

Treasurer—Lewis J. Marchand, Department of Biology, University of Florida, Gainesville, Florida.

Through the courtesy of Marine Studios, Marineland, Florida, members of Sigma Chapter were taken on an all-day cruise of the "Porpoise" off the East coast of Florida last spring on a marine biological collecting trip. Both vertebrate and invertebrate marine forms were collected and studied by the group, and lunch was served on the boat. In the late afternoon we returned to Marine Studios where, as guests of the Studios, we visited the laboratories and saw the attendants feed the porpoises and fishes.

In the last regular meeting of last year it was decided to restrict our social activities and to place more emphasis on scientific lectures. The program as planned for this year includes a series of six lectures: three to be given by Dr. M. A. Brannon, retired Chancellor of the University of Montana, who will speak to us about his work on algae; and three by Dr. George E. Coghill, retired Director of Research of Wistar Institute, who will give lectures on the structure, function, and development of the nervous system. As in the past, Sigma Chapter will continue to sponsor talks by visiting scientists. Our annual banquet will be held in the fall, and a spring

trip to Welaka Conservation Reserve is contemplated.

Several members of Sigma Chapter are anticipating attending the meetings of the American Society of Ichthyologists and Herpetologists which will be held in Gainesville early in April.

COLEMAN J. GOIN, *Secretary.*

Tau

—Duke University

President—Charles Wilson, Biology Building, Duke University, Durham, North Carolina.

Vice-President—Joseph McDermott, Biology Building, Duke University, Durham, North Carolina.

Secretary—Rose Kueffner, 1022 Urban Avenue, Duke University, Durham, North Carolina.

Treasurer—Edyth Hull, College Station, Duke University, Durham, North Carolina.

Upsilon

—Miami University

President—Theodore Howell, Beta Theta Pi, Oxford, Ohio.

Vice-President—Arthur Evans, 400 E. Chestnut, Oxford, Ohio.

Recording Secretary—Jean Allen, 53 Wells Hall, Oxford, Ohio.

Corresponding Secretary—Robert Rech, 106 Stoddard Hall, Oxford, Ohio.

Treasurer—Louis Spriesterbach, 233 Ogden Hall, Oxford, Ohio.

Phi

—University of New Hampshire

President—Paul Shaw, Commons, Durham, New Hampshire.

Vice-President—Robert Blickle, Entomology Department, University of New Hampshire, Durham, New Hampshire.

Corresponding Secretary—Eleanor Hillier, Alpha Xi Delta House, University of New Hampshire, Durham, New Hampshire.

Recording Secretary—Martha Holt, Congreve Hall, University of New Hampshire, Durham, New Hampshire.

Treasurer—Richard Snowman, Sigma Beta House, University of New Hampshire, Durham, New Hampshire.

Plans are being made for the Eastern New England Biological Conference which will be held in Durham in April, 1941.

As a part of the celebration of the twenty-fifth anniversary of Phi chapter of Phi Sigma, open house will be held at Nesmith Hall, the home of biological sciences on our campus, for Phi Sigma graduates on Homecoming Day, October 12.

A field trip into the White Mountains with the new initiates will take place the latter part of the month.

ELEANOR HILLIER, *Secretary*.

Chi

—Montana State College

President—Milton Brown, Botany and Bacteriology Department, Montana State College, Bozeman, Montana.

Vice-President—Shirly Nyman, Botany and Bacteriology Department, Montana State College, Bozeman, Montana.

Secretary—Richard Foote, Entomology Department, Montana State College, Bozeman, Montana.

Treasurer—Evelyn Wood, Botany and Bacteriology Department, Montana State College, Bozeman, Montana.

Psi

—University of Washington

President—John Ellegood, 110 Bagley Hall, University of Washington, Seattle, Washington.

Vice-President—Don McKernon, 2850 W. 69th Street, University of Washington, Seattle, Washington.

Secretary—Eloise Kuntz, 211 Johnson, University of Washington, Seattle, Washington.

Treasurer—John Glud, 4238 12th N. E., University of Washington, Seattle, Washington.

Omega

—University of Oklahoma

President—Marcelotte Leake, Botany Dept., University of Oklahoma, Norman, Oklahoma.

Vice-President—Minnie Jean Matthews, Zoology Dept., University of Oklahoma, Norman Oklahoma.

Treasurer—Elmo Bonifield, Zoology Dept., University of Oklahoma, Norman, Oklahoma.

Secretary—Dorothy Rainwater, Botany Dept., University of Oklahoma, Norman, Oklahoma.

Omega chapter of Phi Sigma enjoyed an active and profitable season last year and we are looking forward to an even better one this year.

At our first fall meeting Dr. G. L. Cross, Professor of Botany, and Dr. A. O. Weese, Professor of Zoology, showed Kodachrome slides taken this summer in Colorado and Arizona. Dr. Charles M. Perry, internationally known philosopher and author of "Looking Toward a Dimensional Realism," delivered an address on "The Essential Unity of the Sciences" at our second meeting.

The next meeting will be November 5. Dr. Coyne H. Campbell will speak on "Ecology and Psychiatry." At the December meeting Mr. Glenn C. Couch, Instructor in Botany, will talk about Ohio State University, from which he has recently returned.

Plans are being made for a picnic on October 18. We are intending to invite as our guests students who are eligible for membership in Phi Sigma so that they may become acquainted with us and our work, and also that we may know them better.

The theme of Omega chapter this year is "Unity of the Sciences." Following out this purpose, we have organized the science clubs on our campus for the purpose of presenting radio programs each week to bring to the students material that is not given in the classroom. Each club is to present one half-hour program every month. These will be of various types: drama, interviews, and round-table discussions.

DOROTHY RAINWATER, *Secretary*.

Alpha Alpha

—University of Southern California

President—Robert Knowles, 942 W. 4th St., Los Angeles, California.

Vice-President—Charles Lockhart, 3987 Menlo Avenue, Los Angeles, California.

Secretary—Valoris Layne, 2022 Marengo Avenue, South Pasadena, California.

Treasurer—Rodrique Gravelle, 11240 Kling St., North Hollywood, California.

Alpha Beta

—Mount Union College

President—Donald Bauman, 2034 Miller Ave., Alliance, Ohio.

Vice-President—George Cain, Miller Hall, Alliance, Ohio.

Recording Secretary—Richard Wilson, 237 Overlook Drive, Alliance, Ohio.

Corresponding Secretary—Merciel Smith, Elliott Hall, Alliance, Ohio.

Treasurer—Kenneth Stoffer, Homeworth, Ohio.

Alpha Epsilon

—University of Pittsburgh

President—Dr. T. Wally Williams, 1001 Cathedral of Learning, Biology Department, University of Pittsburgh, Pittsburgh, Pennsylvania.

Vice-President—Lee C. Truman, 1001 Cathedral of Learning, Biology Department, University of Pittsburgh, Pittsburgh, Pennsylvania.

Recording Secretary—Mary Theiss, 1001 Cathedral of Learning, Biology Department, University of Pittsburgh, Pittsburgh, Pennsylvania.

Corresponding Secretary—Edna Higbee, 1001 Cathedral of Learning, Biology Department, University of Pittsburgh, Pittsburgh, Pennsylvania.

Treasurer—George Wallace, 1001 Cathedral of Learning, Biology Department, University of Pittsburgh, Pittsburgh, Pennsylvania.

Alpha Eta

—Oklahoma A. & M. College

President—Robert Ealy, Route 2, Stillwater, Oklahoma.

Vice-President—Laurence Bewick, 713 College Avenue, Stillwater, Oklahoma.

Secretary—Marguerite Hutchinson, 149 Willard Hall, Stillwater, Oklahoma.

Treasurer—Albert Conway, Route 2, Stillwater, Oklahoma.

Alpha Theta

—State College of Washington

President—LaVerne Brugger, 1505 Maple, Pullman, Washington.

Vice-President—Jack P. Meiners, Ferry Hall, Pullman, Washington.

Secretary—Ruth Weed, 302 Spalding, Pullman, Washington.

Treasurer—R. Fred Goranson, 610 Linden, Pullman, Washington.

Alpha Iota

—Bucknell University

President—Janet Clayton, Women's College, Bucknell U., Lewisburg, Pennsylvania.

Vice-President—William Hulley, Phi Gamma Delta, Lewisburg, Pennsylvania.

Secretary—Lois Farley, New Columbia, Pennsylvania.

Treasurer—Martha Rice, 610 St. George Street, Lewisburg, Pennsylvania.

Alpha Kappa

—Hunter College

President—Mildred Spector, 1871 Harrison Ave., Bronx, New York City.

Vice-President—Shirley Amkraut, 107 Rensen Avenue, Brooklyn, New York.

Corresponding Secretary—Anita Zorzoli, 203 W. 108th Street, New York City.

Recording Secretary—Helen Kalinsky, 644 E. 6th Street, New York City.

Treasurer—Anne Hanson, 1288 Sixth Street, New York City.

In our last letter, Alpha Kappa Chapter set forth plans for a very ambitious season. We are happy to announce that there has been no diminution in the fervor with which these new ideas were instituted.

The interlocking series of lectures on the Endocrine System made by prominent members and research scientists was well received and elicited much interest and we hope some inspiration for younger scientists.

A bulletin concerning requirements for membership to Phi Sigma has been prepared by senior and alumnae members of Alpha Kappa Chapter for cir-

culuation among undergraduate biology students. These will be given into the hands of the instructors for distribution to the students from the freshman year onward so that they may early in their college careers prepare themselves to meet the goal and ideal which is Phi Sigma. A new entrance requirement has been established by the Alpha Kappa Council. Outstanding scholarship in the biological sciences is no longer the only criterion by which new recruits will be judged. A formal paper on some original problem in biological science will be necessary. This, we assume, will create the requisite searching attitude.

Alpha Kappa Chapter intends also to assume a dual character during the coming academic year. Festivities planned are not to be purely biological in intent. Our first meeting is to be celebrated in grand style in the newly completed Park Avenue buildings of Hunter College. The meeting is to be open to all faculty members, undergraduates and friends. Among the distinguished guests will be Dr. George Shuster, President of Hunter College. A social function planned for presentation later in the season is a barn dance—great fun, but still preserving the natural science flavor.

Perhaps the greatest biological event for Phi Sigma this year was the arrival of Loretta Marsh, daughter of Mr. and Mrs. Nicholas Marsh. The proud researcher is the former Irene Borek, one-time President of Alpha Kappa Chapter. Congratulations!

GERTRUDE SILBERMAN, *News Editor*.

Alpha Lambda

—University of Utah

President—Keith Kelson, 568 Elm Avenue, Salt Lake City, Utah.

Vice-President—Marie Lettieri, 1047 Yale Avenue, Salt Lake City, Utah.

Secretary—Lewis Nielsen, 621 Wilmington Avenue, Salt Lake City, Utah.

Treasurer—Patricia Dougall, 523 S. 12th Street, Salt Lake City, Utah.

Alpha Mu

—University and State College of Oregon

President—Maxwell Doty, Botany Department, Oregon State College, Corvallis, Oregon.

Vice-President—Dr. Rosalind Wulzen, Zoology Department, Oregon State College, Corvallis, Oregon.

Secretary—Elaine Bowman, Delta Zeta, 23rd and Van Buren, Corvallis, Oregon.

Treasurer—John Merkel, Botany Department, Oregon State College, Corvallis, Oregon.

Alpha Nu

—University of New Mexico

President—Robert Spenceley, 529 N. Hermosa, Albuquerque, New Mexico.

Vice-President—Edward Kijenski, 824 Forrester Avenue, Albuquerque, New Mexico.

Secretary—Mary Dunn Jamison, 1801 West Central Avenue, Albuquerque, New Mexico.

Treasurer—Robert Bucky, 1635 East Roma, Albuquerque, New Mexico.

Alpha Nu has started the year with two very interesting talks. On September 19, Edward Kijenski spoke on his summer experiences working at the W. K. Kellogg Foundation in southern Michigan. At the second meeting, Mr. E. L. Flory, from the Soil Conservation Service, spoke on range conservation and destruction. He illustrated his talk with slides showing the relation of plants to soil condition.

A Phi Sigma picnic is planned for October 5 for all members of the Biology Department, past and present. We hope that this will mark the beginning of a big year for Phi Sigma's social activities on the campus.

MARY DUNN JAMISON, *Secretary*.

Alpha Xi

—Rhode Island State College

President—Helen Leon, Delta Zeta, Rhode Island State College, Kingston, Rhode Island.

Vice-President—David Smith, Phi Mu Delta, Rhode Island State College, Kingston, Rhode Island.

Secretary—Sylvia Howland, 160 Pierce Avenue, Norwood, Rhode Island.

Treasurer—William Banfield, R. F. D. No. 2, Saunderstown, Rhode Island.

Alumni Secretary—Walton Scott, Jr., Kingston, Rhode Island.

Alpha Omicron —Marquette University

President—Joseph J. Wocasek, 1140 N. 26th Street, Milwaukee, Wisconsin.

Vice-President—Arno F. Michaelis, 3139 N. 8th Street, Milwaukee, Wisconsin.

Recording Secretary—Marjorie Artus, 1810 E. Cumberland Blvd., Milwaukee, Wisconsin.

Corresponding Secretary—Norman C. Olson, 3022 N. Oakland Avenue, Milwaukee, Wisconsin.

Treasurer—Laverne A. Penn, 3415 W. Villard Avenue, Milwaukee, Wisconsin.

Our chapter held its annual picnic on Sunday, June 8, at Terry Andrae State park on the shores of Lake Michigan. This park, characterized by huge

stretches of sand dunes, afforded ample opportunity for the members to study the flora and fauna peculiar to that region. Especially interesting were the ant-lions, or doodle bugs, which abounded in the sandy stretches, and the preponderance of *Juniperus horizontalis* over other types of vegetation. Many insect specimens were collected by the entomology-minded members of our group.

Our local members are working on a variety of research problems. Among those of special interest are: Kenneth MacArthur, the Hippoboscidae; Robert Esser, incomplete nuclear division in one of the apogamous ferns; Marjorie Artus, host-parasite relationships of the mycorrhizae; Ruth Dornfeld, the effects of colchicine on *Zea Mays*; Paul Schmitt, the digestive tract of bot fly larvae; and James Semmens, embryology of the rat.

Our program for the school year's meetings is nearing completion and will go to press shortly. It will be arranged that at least two research problems are to be presented at every meeting representing, if possible, one of botanical and one of zoological interest.

NORMAN C. OLSON, *Secretary*.



New Books

The thumbnail sketches of current biological literature appearing in this section are not meant to be exhaustive or deeply critical. They aim to survey the rapidly growing field of biology. Naturally these reviews represent the candid opinions of various readers not necessarily those of members of the National Council, nor even those of the Editor.

ANIMAL BIOLOGY, ROBERT H. WOLCOTT, *McGraw-Hill Book Co., New York and London, 1940. \$3.50.*

This is a second edition of a general textbook which has won well-merited approval. It was prepared after the author's lamented passing by his colleagues of the University of Nebraska staff. While keeping the plan of the original author much new material replaces outworn passages which have been rendered obsolete by recent research. The improved volume should make new friends.

ATLAS OF OUTLINE DRAWINGS FOR VERTEBRATE ANATOMY, SAMUEL EDDY, CLARENCE OLIVER AND JOHN TURNER, *John Wiley & Sons, New York, 1940. \$1.50.*

Outlines of the important structures in the dogfish, the necturus and the cat, are here presented to the teaching profession in biology who are interested in this more or less new method in laboratory procedure. The drawings are firm and decisive. Each sheet is perforated for removal and filing in a permanent binder, convenient perforations also being supplied.

AN ATLAS OF THE FROG, PAUL L. CARROLL AND WILFRED F. HORNER, *C. V. Mosby Co., St. Louis, 1940. \$1.25.*

This is another set of outline drawings, numbered and labelled, with additional blank pages for notes or extra drawings, as the instructor may desire. 109 pages of lithoprinted material should provide ample assistance in the comparative anatomy class.

BACILLARY AND RICKETTSIAL INFECTIONS, WILLIAM H. HOLMES, *The Macmillan Co., New York, 1940. \$6.00.*

This is a new book for the medical profession, but it will be of interest to bacteriologists, histologists, and physi-

ologists in general, particularly those who are interested in broadening their general information. The style is broadly popular, not too intensely medical,—a feature worth noting.

FUNDAMENTALS OF BIOLOGY, WILLIAM C. BEAVER, *C. V. Mosby Co., St. Louis, 1940. \$4.00.*

This book, of which the 2nd edition is now appearing, has been previously favorably reviewed in the *BIOLOGIST*. It has lost none of its compendious mass of information in reediting, the changes appear to be mostly in the line of better illustration, and the addition of alternative forms for study.

CHINA'S ANIMAL FRONTIER, CLIFFORD POPE, *The Viking Press, New York, 1940. \$2.50.*

Anyone interested in foreign exploration will be interested in this rather more than unusually fascinating work. The author was with the Roy Chapman Andrews expedition into China. Later he took his own expedition into the interior in search of museum materials. How he learned the Chinese language, and what happened on his various forays make up the volume. Youngsters with a bent for collecting will enjoy this work,—so will their elders.

A COLLEGE TEXTBOOK OF HYGIENE, DEAN F. SMILEY, ADRIAN G. GOULD, *The Macmillan Co., New York, 1940. \$2.50.*

This is the third edition of a work which originally appeared in 1928. During the intervening period the authors have had ample time to elaborate and excise on their original offering. It is not primarily intended as a community health manual,—its main objective is the health of the individual student. As such it has much to offer the student, the teacher and the parent

who is wideawake enough to study it. The approach to sex-education is especially sound.

DEVELOPMENTAL ANATOMY,
LESLIE B. AREY, *W. B. Saunders Co., Philadelphia, 1940. \$6.75.*

This is the fourth revised edition of Arey's classical work on human embryology, first appearing in 1924. It has been thoroughly rewritten, over two years having been devoted to the task. Some 1385 drawings have been incorporated into the new edition. The newer information on the age development of the earlier stages of the foetus have also been included. All in all, the book has much to commend it. It will make new friends, and justify the confidence of those who have continued to use the older edition.

DYNAMICS OF INFLAMMATION,
VALY MENKIN, *The Macmillan Co., New York, 1940. \$4.50.*

Based on all the voluminous literature which has risen out of the last ten years study of infection, this monograph has much to offer those who are scientifically interested from the medical or the bacteriological approach. It will, however, have a much wider appeal than to those who are interested in pathology. As such it should fill a much needed place in the literature of morphology, physiology, biochemistry and immunology. That there is much still to be learned in regard to infection and its progress is amply demonstrated. For this reason, alone the book would be stimulating to all biologists.

ELEMENTARY BACTERIOLOGY, J. E. GREAVES AND E. O. GREAVES, *W. B. Saunders Co., Philadelphia, 1940. \$3.50.*

This fourth edition of a well-known standard text brings the last edition up to date in the development of modern bacteriology. It is a compendious work, by reason of the quiz questions appended to each chapter, eminently teachable. Its one weakness, from this reviewer's standpoint being its lack of any bibliography. This makes it difficult to check some of the more trenchant and challenging references to the general literature of the field. However, the question of bibliographies is still mooted as far as elementary

courses are concerned. That previous editions have been popular is ample justification for the authors to omit such impedimenta as would unduly lengthen what is already an adequate presentation.

ELEMENTS OF BOTANICAL MICRO-TECHNIQUE, JOHN E. SASS, *McGraw-Hill Book Co., New York, 1940. \$2.50.*

This is an entirely new offering in the botanical field which should make a definite place for itself in the library of useful volumes which every self-respecting instructor seeks to accumulate. The book has much to commend it. It is brief, yet complete, inexpensive as books go, yet eminently practical, covering both the general microtechnical processes and the more specialized information needed in the preparation of the different plant groups.

ELEMENTS OF BOTANY, R. M. HOLMAN AND W. W. ROBBINS, *John Wiley & Sons, New York, 1940. \$2.50.*

The Holman and Robbins textbook has long been a favorite in botanical courses either as a text or as a correlative reference, this latter being particularly appropriate not only in college, but also in high school courses in botany. Many items of current interest have been included in this revision, artificial pollination, roots in relation to erosion, and hydroponics, being good examples. The high reputation of its predecessors will insure it a sympathetic reception.

ESSENTIALS OF ZOOLOGY, GEORGE E. POTTER, *C. V. Mosby Co., St. Louis, 1940. \$3.75.*

This is an entirely new text. As such it represents the approach to zoological teaching made by an author new to the textbook reading public. While "of the making of books there is no end," as the ancient author epitomized, there is always the ever-present probability that each new work will fill exactly the needs and desires of the teacher who has developed his own ideas, and seeks to find a textbook which he himself is too overburdened, or too modest to write. For such as these a careful study of Potter's new work will make adequate repayments.

EVOLUTION OF THE LAND PLANTS, DOUGLAS HOUGHTON CAMPBELL, *Stanford University Press, Stanford University, Calif., 1940. \$6.50.*

The veteran author of this new work has attained a unique position in the field of American, if not world, plant evolutionists. That this summary of all of his previous work, and of that of all of his contemporaries, will therefore merit the attention of the botanical world, goes without saying. His conclusions as to the origin and main groups of the embryophyta will give the conservative plant taxonomists some very bad moments, as many a student of Campbell's work has already pointed out. The book is well documented, and becomes a "must" for the teaching and research library.

FLORAL MORPHOLOGY, E. R. SAUNDERS, *Chemical Publishing Co., New York, 1940. \$1.50.*

This is the first volume of Saunders' new work which was originally published in England. The book is being reissued by the American agents. It has already been reviewed in past issues of the BIOLOGIST.

FRENCH-ENGLISH SCIENCE DICTIONARY, LOUIS DEVRIES, *McGraw-Hill Book Co., New York, 1940. \$3.50.*

This new dictionary of scientific terms in French is a logical outgrowth of the author's previous German-English science dictionary which appeared some time ago, and won sufficient enthusiastic patronage to warrant a like service for those who are interested in reading the literature of science as it appears in the French journals. The author has wisely refrained from attempting to get all the scientific terminology into this one compact and handy volume. That he has covered in the main all the really useful words, terms and idioms in the fields of agriculture, biology and the physical sciences is entirely adequate for most educational purposes.

FUNDAMENTALS OF BACTERIOLOGY, MARTIN FROBISHER, W. B. Saunders Co., Philadelphia, 1940. \$4.00.

This is the second edition of a text which has already merited favorable attention in the BIOLOGIST. The original plan is adhered to so the shift from old to new editions will not un-

duly upset the program of teachers who have established a set method of presenting the subject. The new edition continues its emphasis on non-pathogenic bacteria of economic importance, and leans heavily to the biochemical and bio-physical aspects of the subject. It is unquestionably one of our better texts in the field.

FUNDAMENTALS OF PERSONAL HYGIENE, WALTER W. KRUEGER, W. B. Saunders Co., Philadelphia, 1940. \$1.75.

The third edition of this elementary manual for junior college classes has profited by the addition or expansion of chapters devoted to the hygienic aspects of sex, health fads and fallacies, habit-forming drugs, the common cold and tuberculosis. Teachers seeking for a handy, compact and fairly brief although adequate manual should be interested.

A GENERAL ZOOLOGY OF THE INVERTEBRATES, G. S. CARTER, *The Macmillan Co., New York, 1940. \$5.50.*

The distinguished professor in the University of Cambridge who has produced this new work well merits the laudatory introduction which Julian Huxley has contributed to it. American biologists who are looking for taxonomic discussions of the various phyla will be disappointed. The book is, as its title indicates, a general zoology, and wisely confines itself to four main fields of study,—protoplasm and the free-living cell, the multicellular body, comparative physiology, and some general problems of invertebrate zoology, such as the life histories, behavior, and habits of the invertebrata.

HANDBOOK FOR DISSECTORS, J. C. BOILEAU GRANT AND H. A. CATES, *The Williams & Wilkins Co., Baltimore, 1940. \$2.50.*

The senior author of this handy little volume some time ago published a "Method of Anatomy." Used with that volume was a series of mimeographed instructions. These have now been issued in book form. For students of human anatomy in medical dissection the manual should be valuable.

FLORA HAWAIIENSIS, OTTO DEGENER, 2220 University Ave., Honolulu, 1940. \$3.50.

This is the fourth century of the

series of illustrated sheets describing the plants of the Hawaiian territory which has been favorably commented upon in previous issues of the BIOLOGIST. The same unique loose-leaf method has been followed in its presentation. It will bring up to date and correct many of the previous sheets, as well as expand the entire four-volume set.

HUMAN BIOLOGY, GEORGE A. BAITSELL, *McGraw-Hill Book Co., New York, 1940. \$3.75.*

This entirely new work is a laudable attempt to base a course in biology, not on a series of invertebrate or vertebrate animals living or dead, but on the student himself. In such an attempt it goes without saying that man's first interest is still man. This being the case the author is blazing a new trail through the tangle of biological teaching. That he has the courage of his convictions in so doing is praiseworthy—that he has succeeded as well as he has is worthy of congratulation. Instructors should note the fact that this work is no petty human hygiene, but a thoroughly scientific and objective presentation of the principles of biology in their application to the human being. It is a work that has long needed doing, and should merit close attention from zoologists in particular.

INGALIK MATERIAL CULTURE, CORNELIUS OSGOOD, *Yale University Press, New Haven, 1940. \$4.00*

Anthropologists and ethnologists will be interested in this the 22nd number in the Yale University Publication in Anthropology. It deals with the culture of an Athapaskan village on the lower Yukon. A surprisingly interesting mass of information has been accumulated here, carefully analyzed and organized. Even one who is not a professional anthropologist will find it absorbingly interesting.

INTRODUCTION TO ENTOMOLOGY, JOHN H. COMSTOCK, *Comstock Publishing Co., Ithaca, N. Y., 1940. \$5.00.*

This is the ninth edition of a book which has come to be regarded as one of our American classical entomologies. It has been brought up to date by Glenn W. Herrick, who has wisely seen fit to devote more space to the destructive insects which parasitize the forms in-

jurious to agricultural pursuits. There are 1228 illustrations, a twenty page bibliography, and a very extensive index which all add to the usefulness of this 1064 page book.

INTRODUCTION TO PARASITOLOGY, ASA C. CHANDLER, *John Wiley & Sons, New York, 1940. \$5.00.*

Here is the sixth edition of another biological classic text, one which has come to be regarded as a standard for comparison in its field. With the increasing stress that has come to be placed on parasites in general, and on human parasites in particular, this new edition, including all the important ones, is particularly opportune.

LABORATORY MANUAL OF GENERAL BIOLOGY, J. G. ARNOLD AND T. L. DUGGAN, *C. V. Mosby Co., St. Louis, 1940. \$1.50.*

This is a loose leaf collection of laboratory exercises, planographed on only one side of the sheets, leaving ample room for sketching where special drawing paper is not required. It is divided into three sections, the first being devoted to botany, the second to invertebrate, and the third to vertebrate zoology. It will be of interest and probably valuable to instructors who wish to base their laboratory work on the comparative morphologies of the extensive number of forms studied. However, there seems to be an entire innocence of any physiological material—a lack which the present physico-chemical approach to biology renders rather conspicuous.

LABORATORY MANUAL OF BIOCHEMISTRY, HARROW, STONE, BORZEK, WAGREICH AND MAZUR, *W. B. Saunders Co., Philadelphia, 1940. Paper, \$1.50.*

Designed to accompany the senior author's "Textbook of Biochemistry," (reviewed in this issue), this comparatively small and compactly spiral-bound manual presents some fourteen chapters of experiments with anywhere from six to thirty to each chapter.

THIS LIVING WORLD, C. C. CLARK AND R. H. HALL, *McGraw-Hill Book Co., New York, 1940. \$3.25.*

This is the first of a set of two books which appear to be well adapted to the popular survey courses which are sweeping the country. The present and

first volume deals with the living world, and human beings. It is interesting and quite comprehensive.

THE LOUSE, PATRICK A. BUXTON, *The Williams & Wilkins Co., Baltimore, 1940. \$3.00.*

This little monograph by the professor of medical entomology at the University of London very thoroughly covers an interesting subject about which not too much is definitely known. Not only is the subject presented anatomically, but its life history, medical importance and control are all very adequately discussed.

A MANUAL OF AQUATIC PLANTS, NORMAN C. FASSETT, *McGraw-Hill Book Co., New York, 1940. \$4.00.*

This is a very valuable new taxonomy and key to the more common aquatics in the area between the Minnesota-Missouri line and the St. Lawrence Gulf to Virginia area. It includes a well illustrated general key, a descriptive section, and, to lovers of wild-life, most interesting of all, an appendix which covers the use of aquatic plants by birds and mammals, an animal index, the relations of plants to fish. There is also a glossary. The book is profusely illustrated with accurate line drawings. It should be seen to be appreciated.

MATERIAL BASIS OF EVOLUTION, RICHARD GOLDSCHMIDT, *Yale University Press, New Haven, 1940. \$5.00.*

This book is the formal presentation of the 1939 Silliman Lectures at Yale University. In them, Dr. Goldschmidt maintains that neo-Darwinian evolution is to be looked for within the species, and is untenable as a final and total theory of evolution. To the larger groups Goldschmidt would apply the mutation theory.

MEDICAL BIOMETRY AND STATISTICS, RAYMOND PEARL, W. B. Saunders Co., *Philadelphia, 1940. \$7.00.*

This is the third edition of a work which has set more than one standard in the biometrical and statistical field. As such it may be to the old-fashioned descriptive scientist more or less caviar to the general. Primarily designed for the medical field, much of the illustrative material is chosen from that area.

METHOD OF ANATOMY, J. C. BOILEAU GRANT, *The Williams and Wilkins Co., Baltimore, 1940. \$6.00.*

This second edition of a well and favorably known manual of human anatomy. It first appeared in 1937, only three years ago. That a new edition has been needed and demanded in so short a time is a compliment to its general usefulness. There are some 650 illustrations, all of them clear and to the point. One interesting phase of the work is its usefulness to physicians and surgeons, as well as to medical students.

MICROSCOPIC ANATOMY OF VERTEBRATES, J. I. KENDALL, *Lea & Febiger, Philadelphia, 1940. \$3.75.*

This second edition is, like its predecessor built up about the microscopic anatomy of forms outside the mammalian groups, such as the dogfish, necturus, frog, lizard and pigeon. Designed to prepare chiefly for a later course in human histology the chief aim of the book is the acquisition and mastery of techniques which will be necessary later in medical schools.

MICROSCOPIC WORLD, FRANK THONE, *Julian Messner, New York, 1940. \$3.00.*

The author of this engagingly popular work on microscopic study has been one of the staff writers for "The Science News Letter" for a number of years. In the weekly periodical he usually writes "Nature Rambles," although many a special article appears over his signature. In the presentation of this volume the author's flair for accurate, descriptive yet interesting writing has had an excellent chance to take its fling. The result is to be commended. This is no child's book, written down to the juvenile mind. It is an honest-to-John study of the microscopic world so clearly presented that the untrained layman can enjoy it, read it with both illumination and profit. The world needs more scientific word-wizards like Frank Thone, and, lest we forget, more micro-portrayers like his collaborator, Dr. George Roemmert. They have done a bully job.

OUTLINE OF GENERAL ZOOLOGY, GORDON ALEXANDER, *Barnes & Noble, New York, 1940. Paper \$1.00.*

The educational world is deeply in-

debted to the publishers of this handy compend—as it is for all the rest of the excellent series—for placing in the student's hands a thorough, comprehensive, yet clear analysis of the entire field of general zoology. Not the least of its merits is the fact that it is correlated with fourteen better-known, and outstanding college text-books. It merits closer study and deeper acquaintance.

TEXTBOOK OF BIOCHEMISTRY,
BENJAMIN HARROW, W. B. Saunders
Co., Philadelphia, 1940. \$3.75.

The original edition of this work appeared only two years ago. That a new edition has been required in so short a time speaks volumes for its popularity—and its practicability. The representative list of collaborating critics who passed on the several chapters reads like a "Who's Who" of modern physiology and biochemistry. None of the salient features which made the first edition so popular has been omitted in this revision. There has been some expansion (70 pages) to incorporate new material on the more recent results of vitamin research, the sulfanilamides, tobacco mosaic, bacteriophage and the like.

PRINCIPLES OF GENETICS, E.
GRACE WHITE, C. V. Mosby Co., St.
Louis, 1940. \$2.50.

This is another new book, designed for a single semester three-credit course in genetics or heredity. There has been an excellent choice of material for so abbreviated an approach to a subject which is, at best, full of educational pitfalls. The book is well illustrated, both by diagrams and photographs. There is a list of well chosen references and a set of review questions at the end of each chapter.

TEXT-BOOK OF ZOOLOGY, T. JEFFREY
PARKER and WILLIAM A. HASWELL,
Macmillan Co., Ltd., New York and
London, 1940. \$9.00.

At last a new edition of Parker and Haswell is under way, the first in nineteen years. This first volume includes the protozoa, the coelenterates, platyhelminthes, the nematodes, the annelids, the arthropods, the molluscs, the bryozoans and the echinoderms.

Although there has been much substitution of new for old material, the salient features which made a classic of the original volumes have been so largely retained that one used to the old feels instinctively at home in the new.

TEXTBOOK OF PHYSIOLOGY,
WILLIAM H. HOWELL, W. B. Saunders
Co., 1940. \$7.50.

Four years ago the thirteenth edition of this book was reviewed in the *BIOLOGIST*. Meanwhile physiology has not stood still, its volume of research continues unabated. Hence another revision has been necessary to keep this standard textbook up to date. The 1117-page volume contains some 329 illustrations. All in all, there is little to say in the face of such success as this manual has achieved. Here, as elsewhere, the proof of the pudding is in the eating.

UNRESTING CELLS, R. W. GERARD,
Harper & Brothers, New York, 1940.
\$3.00.

Taking its cue from John Masefield's poetic lines "What am I, Life? a thing of watery salt, Held in cohesion by un-resting cells?" this new work embarks on a treatment of physiology which is to say the least refreshing. It is hard to imagine a class which would not be stimulated by it. Diagrammatic illustrations, so characteristic of the Chicago method, are everywhere present, and contribute more than their fair share to a better understanding of the really complicated physiological processes under discussion. Here is another work which must be seen and studied to be fully appreciated.

VIRUS, KENNETH M. SMITH, *The Macmillan Co., New York—Cambridge, England, at the University Press,* 1940. \$2.00.

The complete title of this brochure is "The Virus: Life's Enemy," and it is a more or less popular and non-technical account of the history of viruses, their discovery, methods by which they are studied, how they are propagated, and what they do. The British have a genius for making scientific subjects both understandable and interesting. Hence this work is worthy of attention.

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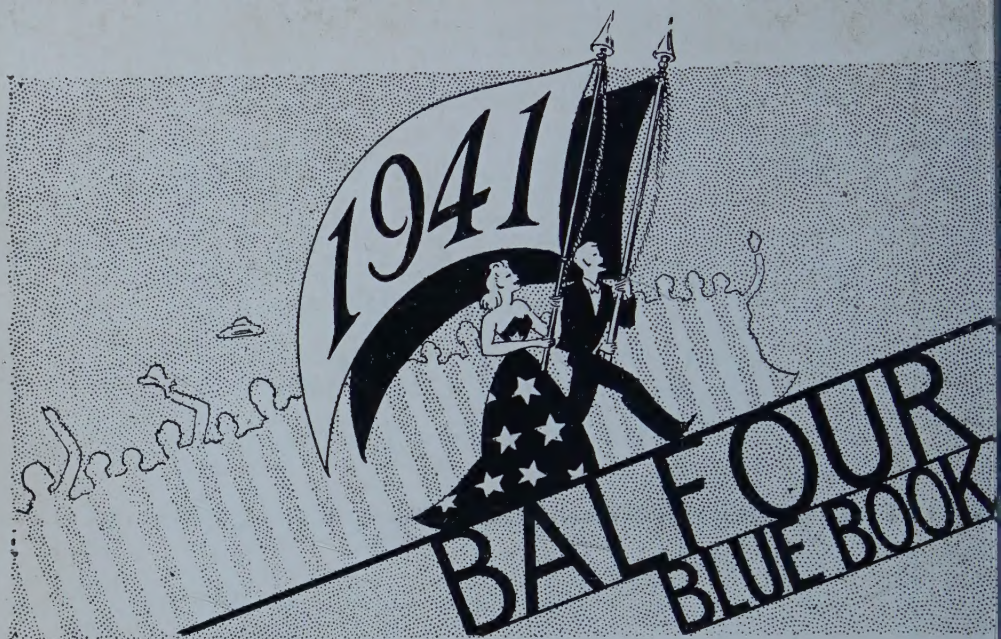
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